Wind Power Optimizer

Installation Manual

Femtogrid Solar System: the sunny side of shade

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1 Explanation of the symbols used

To ensure optimal usage of this document, we start by explaining the symbols used in this installation manual for the Wind Power Optimizer.

This symbol indicates an example.

This symbol indicates a note, which, if ignored, will make the procedure or operation more difficult.

This symbol indicates a fact, which, if not observed, could result in damage to components or represents danger to persons. Read these passages carefully.

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2 Introduction

2.1 General

Thank you for buying this product and helping the world to become greener by adding a sustainable energy system on this planet. Your renewable energy system produces grid-ready renewable energy that contributes to the global reduction of CO2 emission and stimulates the transition from conventional fossil energy sources to renewable energy sources.

2.2 Target group document

Authorized installers must install this product. In addition, the installer must follow the regulations of the local grid operator. The installer must read this installation guide carefully and must ensure compliance with all prescribed safety regulations, the technical connection requirements of the local grid operator and any other applicable provisions.

2.3 Introduction to the Femtogrid Wind System

The Femtogrid Wind System consists of 4 components:

- Femtogrid Wind Power Optimizer (one for each Urban Wind Turbine installed)
- Femtogrid Inverter 2400 (or multiple Inverters 2400)
- Femtogrid DC Cable(s)
- Femtogrid Monitoring (wireless monitoring system) consisting of a Monitoring Box and a Monitoring Portal

2.4 Validation document

This document is only valid for Wind Power Optimizers with the following nameplate. Keep this guide in a convenient place for future reference.

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3 Safety instructions

3.1 Installing the Femtogrid Wind System

Make sure that the Wind Turbine cannot spin free. The turbine must be braked during installation or maintenance (e.g. with tie-wraps). When the turbine runs free it can be damaged or cause damage to the Wind Power Optimizer.

The installation of the Wind Power Optimizer must be carried out by authorized installers and performed in accordance to local and national regulations (e.g. the regulations for the Netherlands are covered by the NEN1010).

The installation of the Inverter 2400 must be carried out by authorized installers and performed in accordance to local and national regulations (e.g. the regulations for the Netherlands are covered by the NEN1010).

Do not connect the Inverter 2400 to the DC grid before all Power Optimizers are installed. The DC grid may be charged up to 400 Vdc when connected to the Inverter 2400. Do not touch the inside of the DC connectors.

3.2 High voltages inside the Wind Power Optimizer and the Inverter

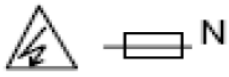
Do not open the housing of the Inverter or the Wind Power Optimizer. This is not needed during operation. Only the Wind Power Optimizer may be opened for installation purposes and it should only be done by authorized installers. Warranty will be void after opening the housing of the Power Optimizer or the Inverter.

3.3 Femtogrid DC bus safety warnings

If the Femtogrid female DC connector is disconnected from the inverter, the power of all equipment on the bus (DC grid) will be disconnected. However, if the DC cables or connectors are damaged, it is possible to get electrical shocks.

Place a protection or end cap on the 'OUT' (female DC) on open connectors of Power Optimizers. Normally it is not possible to directly touch the high voltage, but without an end cap, water can get into the connector and can cause malfunction of the system.

CAUTION: DOUBLE POLE / NEUTRAL FUSING



3.4 Connection area

Do not open the FG-PO2500-UW001 Wind Power Optimizer. Dangerous voltages can be inside this device.

Do not switch on the Inverter 2400 (AC power) before finishing the total installation. The safety switches of the FG-PO2500-UW001 Wind Power Optimizer are activated once the AC power is switched on. The DC bus is then charged to a potentially dangerous voltage. After System –Power-On the turbine braking functionality will be released after 3 minutes to give the Inverter time to attach to the AC grid first.

The Wind Power Optimizer MUST be earthed by mounting an earth wire on the bottom of the device and connect it to the installation Earthing.

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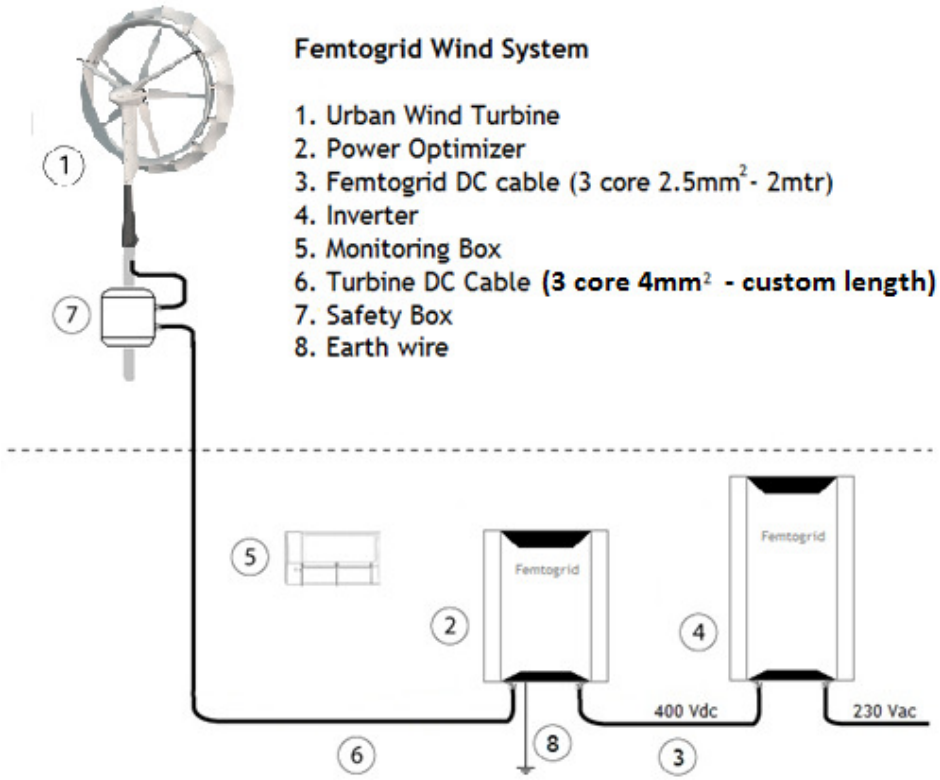
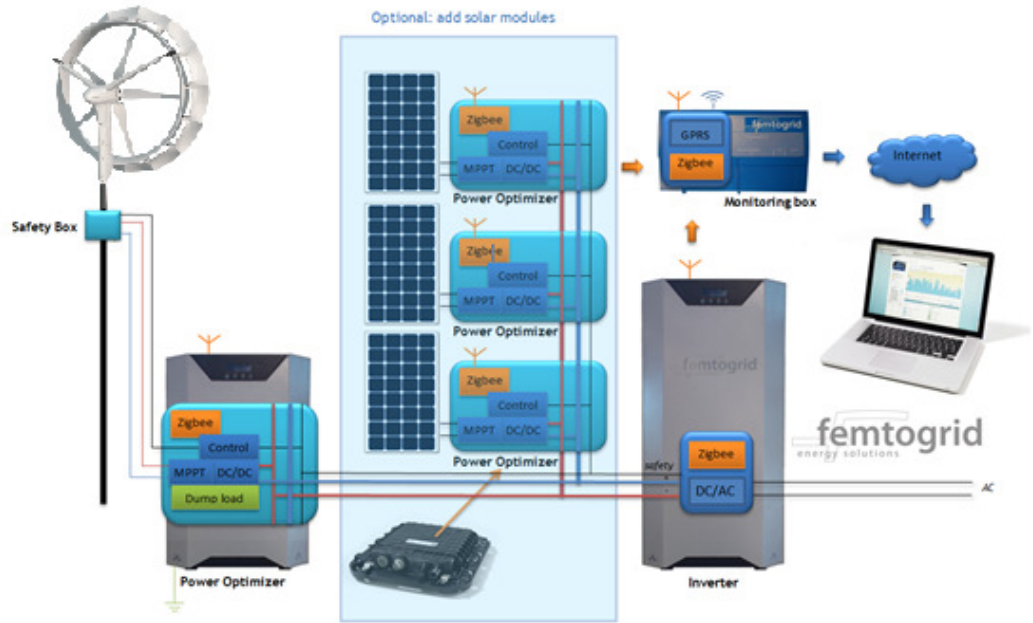
4 Schematics Femtogrid Solar System

The schematic overview presented below shows all components of the Femtogrid Wind System.



The data communication is wireless using a Zigbee network and has no influence on the power generation.



Depending on the local wind conditions, it is possible to make a system with more than one Power Optimizer on one inverter. Beside Wind Power Optimizers you can add Sun Power Optimizers.

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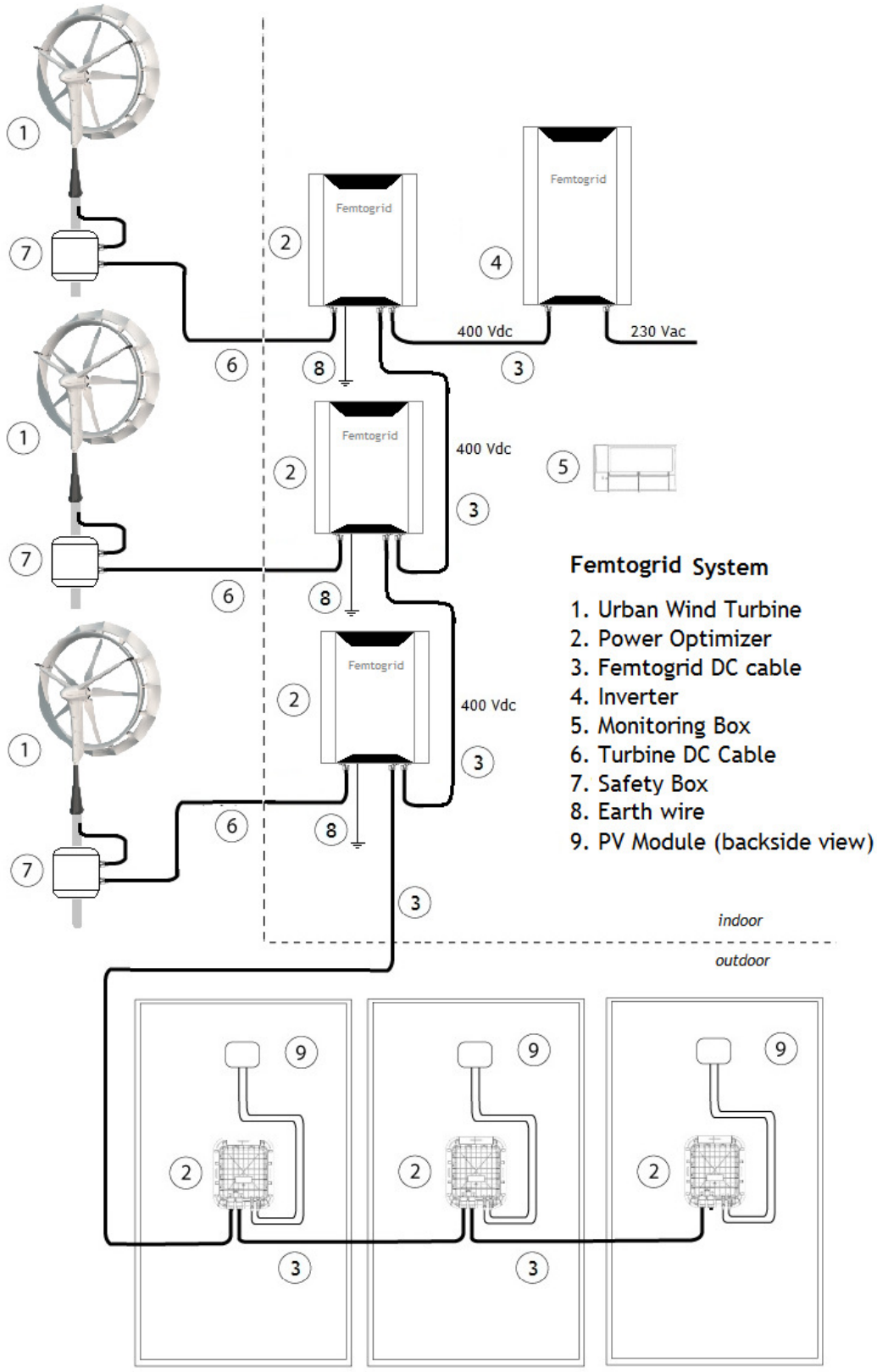
A few solar panels improve the efficiency of system. During the day they level out the consumption of the system and let the inverter feed energy to the grid. Result: a faster reacting system.



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5 Short installation sequence

To ensure a safe, quick and easy installation, we advise to follow the following installation sequence:

1. **Tie-wrap the wind turbine to avoid free spinning of the turbine.** Make sure that it is save to work on the cables from the wind turbine.
2. **Check if the safety box is installed correctly** according to the mounting instructions in chapter "8.4 Connection from the Safety box".
3. **Mount the Wind Power Optimizer** according to the mounting instructions in chapter "7.5 Mounting the Wind Power Optimizer onto the wall". Place the optimizer indoor, in range of the delivered cable length to the inverter.
4. **Connect the Wind Turbine to the Safety Box** according to the installation instructions in chapter "8.2 **Connecting** the Wind Turbine to the Safety box".
5. **Connect the Safety box to the Wind Power Optimizer** at the Wind DC input on the bottom left side of the Wind Power Optimizer according the installation instructions at chapter "8.4 Connection from the Safety box to the Wind Power Optimizer".
6. **Connect the Wind Power Optimizer to the Inverter with a Femtogrid cable (Female-Female**). If a custom length cable is used, follow instructions in chapter "8.1 Assemble the Femtogrid DC cable connector".
7. **Install an earth wire between the earth of the installation and the earth mounting screw on the bottom of the Wind Power Optimizer.**
8. **Activate the monitoring box,** by **pressing the button** with a small pointy object (e.g. toothpick) **for at least 5 seconds during power up.**
9. **Assemble the AC connector (female) and connect the inverter to the mains** according to the instructions of the inverter.
10. **Power up the Inverter.**
11. **Enter date, time, language and country on the display of the Inverter and the Wind Power optimizer**. After setting these values, the **question "search for network?"** appears.

- When **no monitoring box** is **installed**, **answer "No" and go to step 15**.
- When a **monitoring box** is **installed**, **do not answer the question, first execute step 12.**

12. **Press the button of the Monitoring Box shortly.** The green led will start to blink for two minutes. During this time Power Optimizers and the inverters can enter the network of the Monitoring Box. The Solar Power Optimizers will join automatically to this network. The Inverter(s) and the Wind power Optimizer(s) need to be added manually.
13. **Answer "Yes" on the question "search for network?" to join the network at the Inverter and the Wind Power Optimizer.** The devices will answer "joined to network" If multiple Inverters and/or Wind Power Optimizers are installed repeat steps 10 to 12 for the other Inverters and Wind Power Optimizers.
14. **Check if the wireless data network is installed**. Follow the following route in the setting menu of the Wind Power Optimizer. Settings -> Zigbee network -> node list. It should show the surrounding Power Optimizers, Inverters and the monitoring box. (the Power Optimizer cannot see its self).
15. **Check power conversion** on the display of the Wind Power Optimizer.
    With **powerful wind**, press **two times the up button**, to check the **actual converted power.**
    When the turbine rotates with **no powerful wind**. Press **two times the down button** to check the **generator voltage**.

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6 Maintenance

The Wind Power Optimizer is equipped with an integrated dump load. In some cases it can happen that the device uses this dump load to brake the wind turbine. In these cases the heatsink of the Wind Power Optimizer can reach temperatures of 65 degrees. Therefore it is important to do the following maintenance:

6.1 Yearly maintenance Wind Power Optimizer

1. **Inspect / vacuum-clean the backside of the Wind Power Optimizer for dust, papers, etc. Due to active braking this side can heat up to 65 °C.**
2. **Check connections for corrosion and correct mounting.**
3. **Check the earth wire and connection.**
4. **Test the safety stop cycle :**
    a. **Check the wind speed on the display of the Wind Power Optimizer, this must be higher than 2m/sec. (this is a turbine voltage of 10-30 VDC)**
    b. **When it is higher than 2m/s, hold the back button for more than 5 seconds. This triggers the forced switch off of the Power Optimizer**
    c. **Wait for 5 seconds for the safety box to brake the turbine.**
    d. **Check the turbine voltage on display of the Wind Power Optimizer. This should drop below 5 Vdc.**
        - **Turbine voltage > 5Vdc = Replace safety box**
        - **Turbine voltage < 5Vdc = OK**
    e. **When the safety stop cycle is correct the Wind Power Optimizer can be started again by holding the back button for 5 seconds.**

6.2 Maintenance wind turbine

The wind turbine is a device with turning parts. These parts need maintenance for a long lifetime of the equipment and safe operation is very important to follow up the instructions of the manufacturer.

Follow the maintenance procedure of the Turbine manufacturer.

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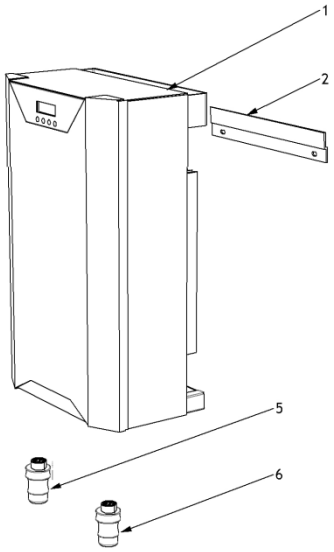
7 Mechanical installation of the power Optimizer



7.1 Check parts

1. Wind Power Optimizer
2. Mounting bracket
3. User manual
4. Installers manual
5. Cable gland (mounted in Wind Power Optimizer)
   (Used to connect to Wind Turbine)
6. Femtogrid connector or cable (supplied separately)
   (Used to connect to DC Femtogrid)

7.2 Check for damage of the products

Check the DC cables for damage. Cuts in DC cables or broken DC connectors can cause malfunctioning of the Femtogrid System and may cause dangerous situations. Check the Inverter and the Wind Power Optimizer. If damaged, contact your supplier.

7.3 Choosing the mounting location

DANGER to life due to fire or explosion.

Despite careful construction, electrical devices can cause fires.

• Do not mount the Inverter or Wind Power Optimizer on flammable construction materials.

• Do not mount the Inverter or Wind Power Optimizer in areas where highly flammable materials are stored.

• Do not mount the Inverter or Wind Power Optimizer in areas with a risk of explosion.

The Wind Power Optimizer is only suitable for indoor placement. It is not allowed to place the Wind Power Optimizer outside where it is exposed to rain and other weather conditions.

If more Wind Power Optimizers are installed be sure that the Wind Power Optimizers are not placed above each other. This has a bad influence on the heat dissipation of the Wind Power Optimizer.

To ensure good wireless communication for the web monitoring portal it is important to place the inverter in range of the wireless network of the Power Optimizers. For example: in the loft right under the roof. If this is not possible, there are two ways to enlarge the range of the wireless network. First mount the Monitoring Box on a strategic place between the Power Optimizers and the inverter. If this doesn't work, additional repeaters are necessary to enlarge the range of the wireless network. For more information on the monitoring system, see the manual of the Monitoring Box. The inverter and Power Optimizers do not need the wireless network to convert the energy properly.

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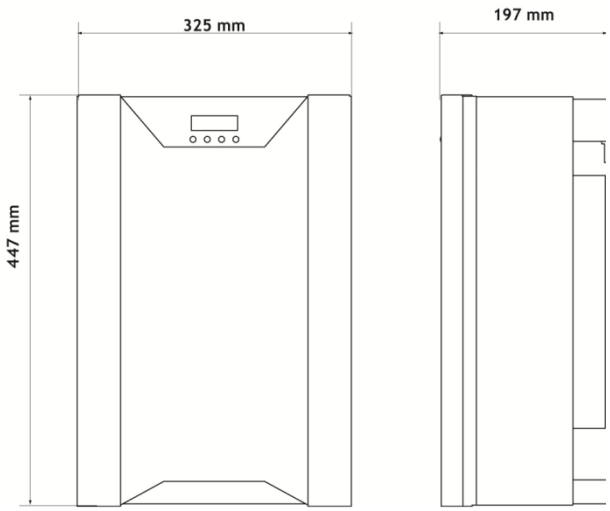
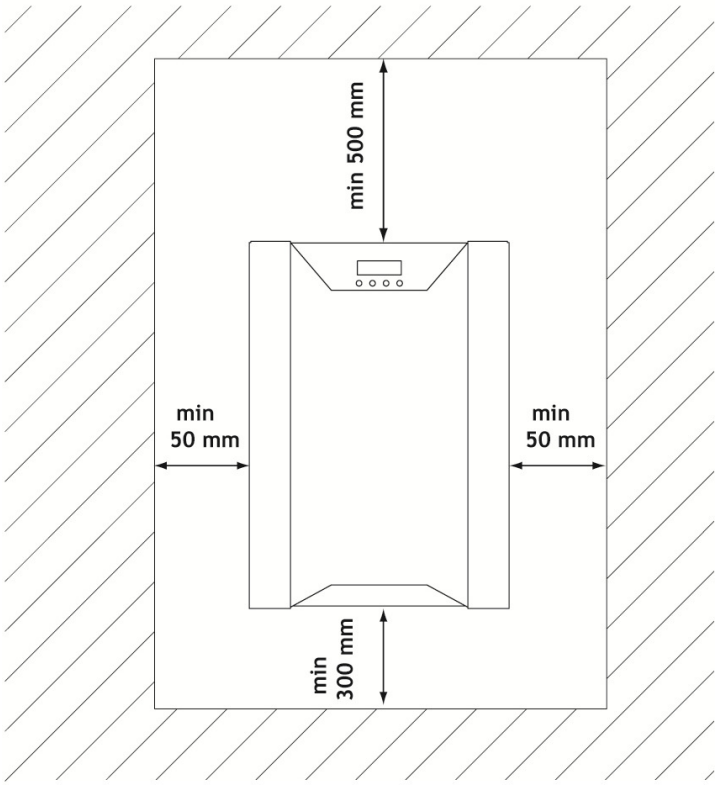
7.4 Dimensions



7.5 Mounting the Wind Power Optimizer onto the wall

Choose a place that allows the Wind Power Optimizer to conduct its heat. A range of 50 cm above the Wind Power Optimizer must be clear of obstacles.



Make sure the Wind Power Optimizer hangs vertically. Do not place the Wind Power Optimizer horizontally.

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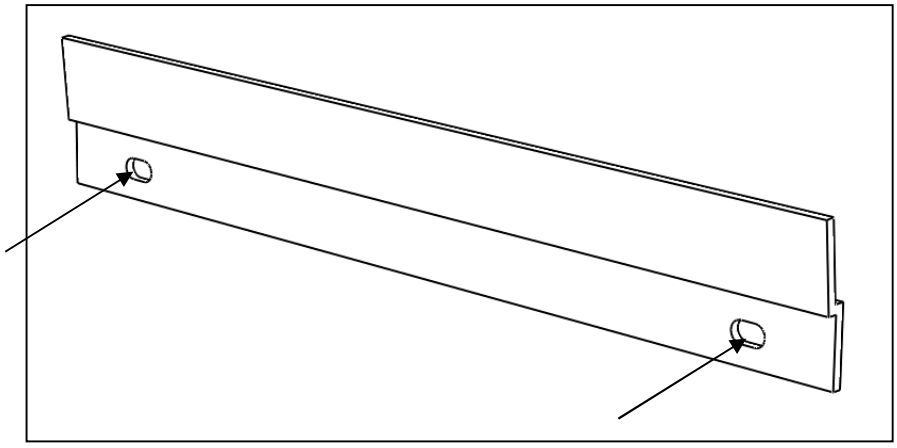
7.6 Instructions mounting plate

Screws and plugs are not included. Each wall needs different screws and plugs to ensure a solid fixation.

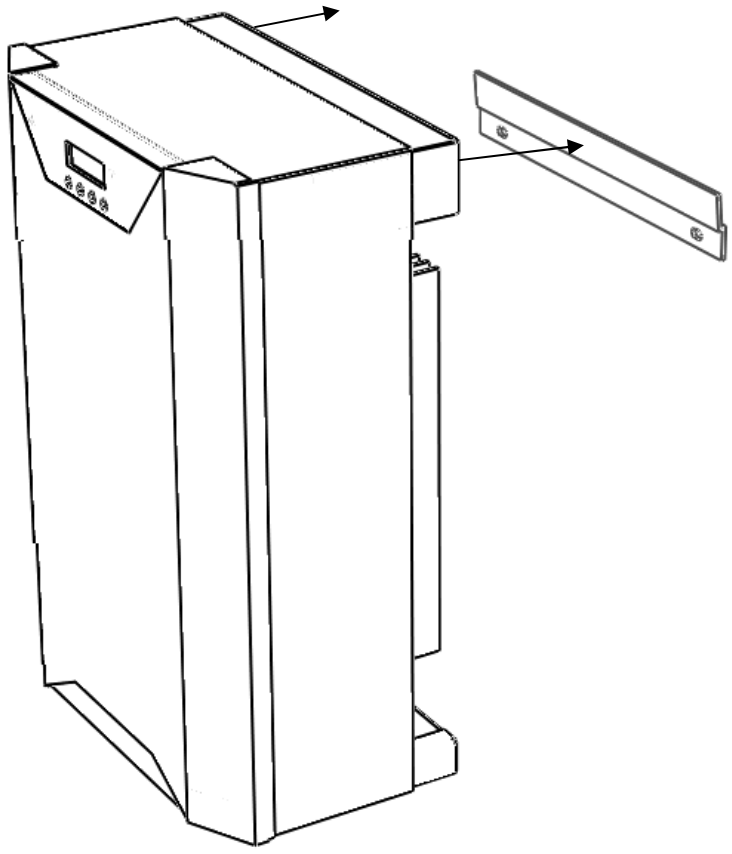
Take the weight of the Wind Power Optimizer in account when choosing the appropriate mounting material. The weight of the Wind Power Optimizer is ± 15kg.

1. Use the mounting plate to mark the drill holes on the wall.



2. Attach the mounting plate to the wall using appropriate screws and washers.

3. Place the Wind Power Optimizer on the mounting plate.



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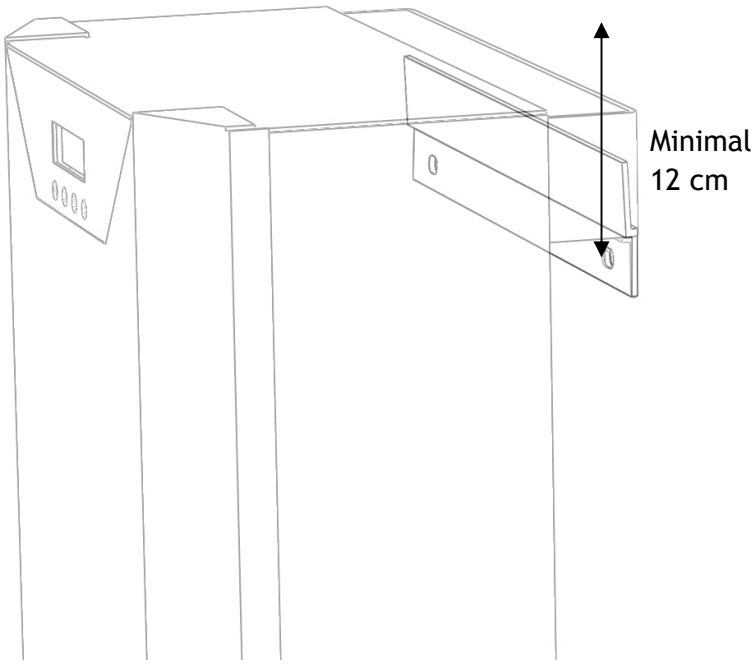
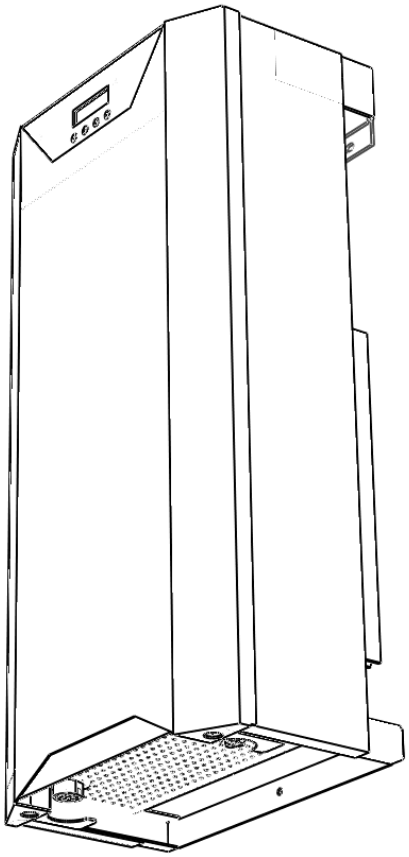
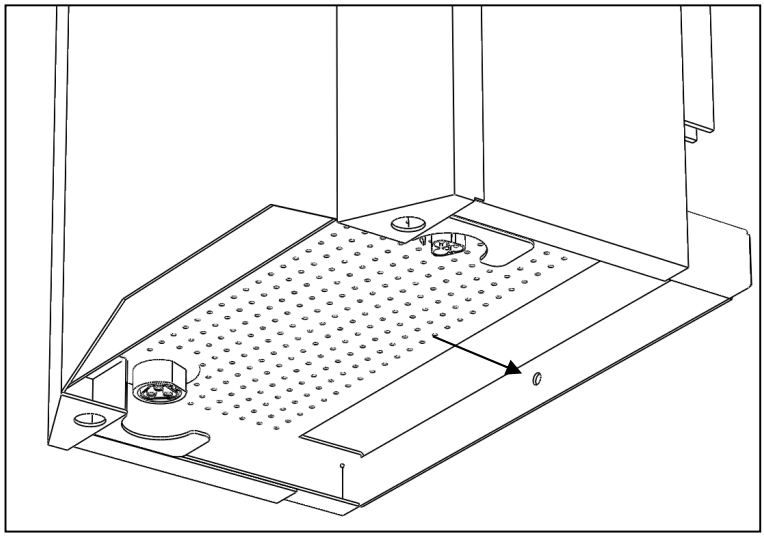
4. Check if the Wind Power Optimizer is correctly aligned on the mounting plate.



5. Use the Wind Power Optimizer to mark the drill hole on the wall.

6. Lock the Wind Power Optimizer with a screw on the bottom.





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8 Connection area

Do not open the Wind Power Optimizer during operation. Opening of the Wind Power Optimizer is only allowed for installation purposes and should only be done by authorized installers. NOTE: an "allen screw (or Socket head cap screw)" in the left bottom should be removed before opening the frontcover. (and placed back after closing

Do not switch on the AC power on the Inverter before finishing the installation. The safety switches of the Power Optimizer are activated when the AC power is switched on. The DC bus can be charged to a potentially dangerous voltage.

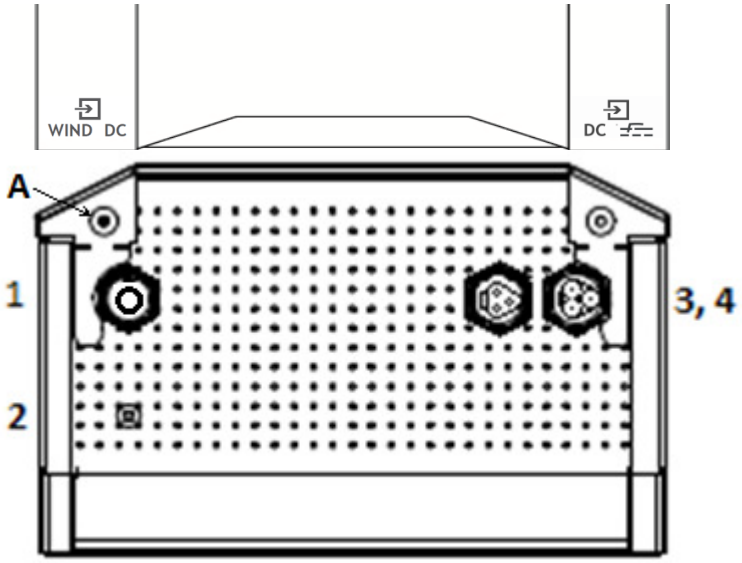
Use of the special Femtogrid cable is prescribed for this installation. This cable is specified for outdoor use.

Materials: **According to TÜV 2 Pfg 1169/08.2007.**

Insulation: **Special XL-HFFR compound.**

Conductor: **Tinned copper conductor according to class 5 of IEC 60228.**

The Wind Power Optimizer has four electrical connection points and one screw to (un)lock the frontcover at the bottom of the device.



A: Allen screw (or Socket head cap screw) for (un)locking Frontcover.

1: Cable gland entry point for Turbine DC cable

2: Earth Connection point

3: Female Femtogrid Connector (Input from second or more Power Optimizers)

4: Male Femtogrid Connector (Output to the Inverter)

The earth connection point must be connected to system earth!

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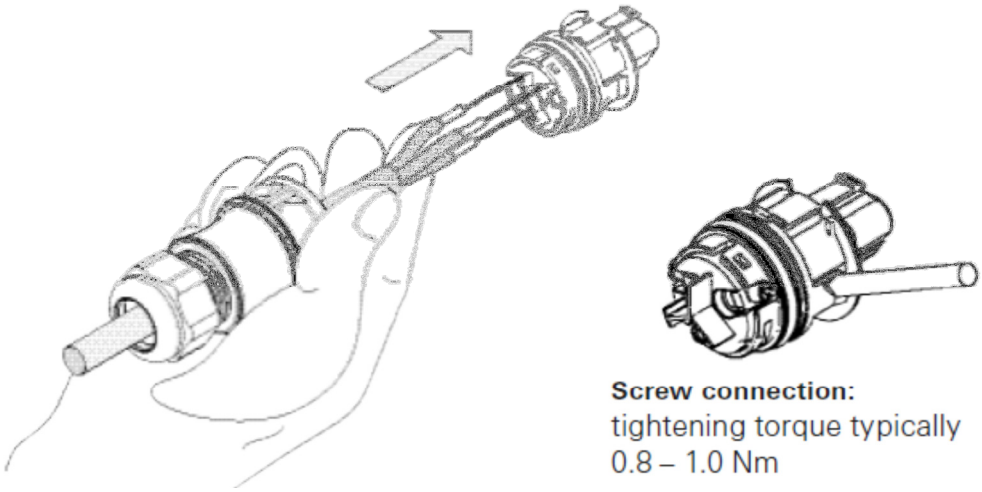
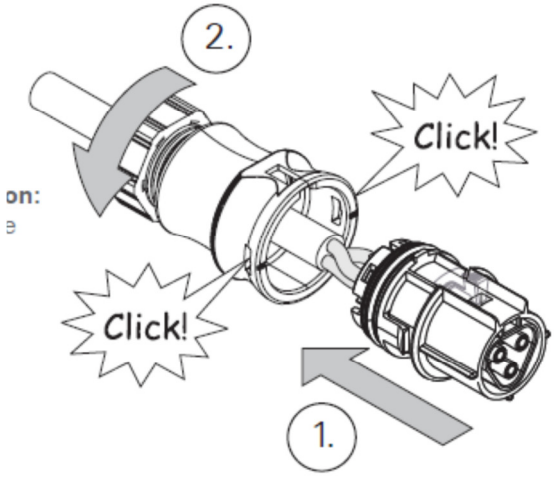
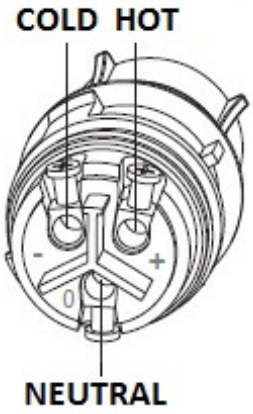
8.1 Assemble the Femtogrid DC cable connector

Connect the Femtogrid DC cable socket with the special Femtogrid DC cables. Strands with a cross-section of minimal 2.5 mm^2 to maximal 4 mm^2 can be connected.



1. Push the rear part of the socket over the DC cable.
2. Press wire end sleeves onto the stripped strands.
3. Use the Femtogrid DC cable and connect the individual 3 wires with the insert in turn as follow:
   - **HOT** conductor on screw terminal with label **+ (Red)**
   - **Cold** conductor on the screw terminal with label - (**Blue**)
   - **Neutral** conductor on the screw terminal with label O **(Black)**
4. Ensure that the wires are connected properly.
5. Snap the rear part of the socket onto the socket insert.
   Tighten the screwed cable gland.





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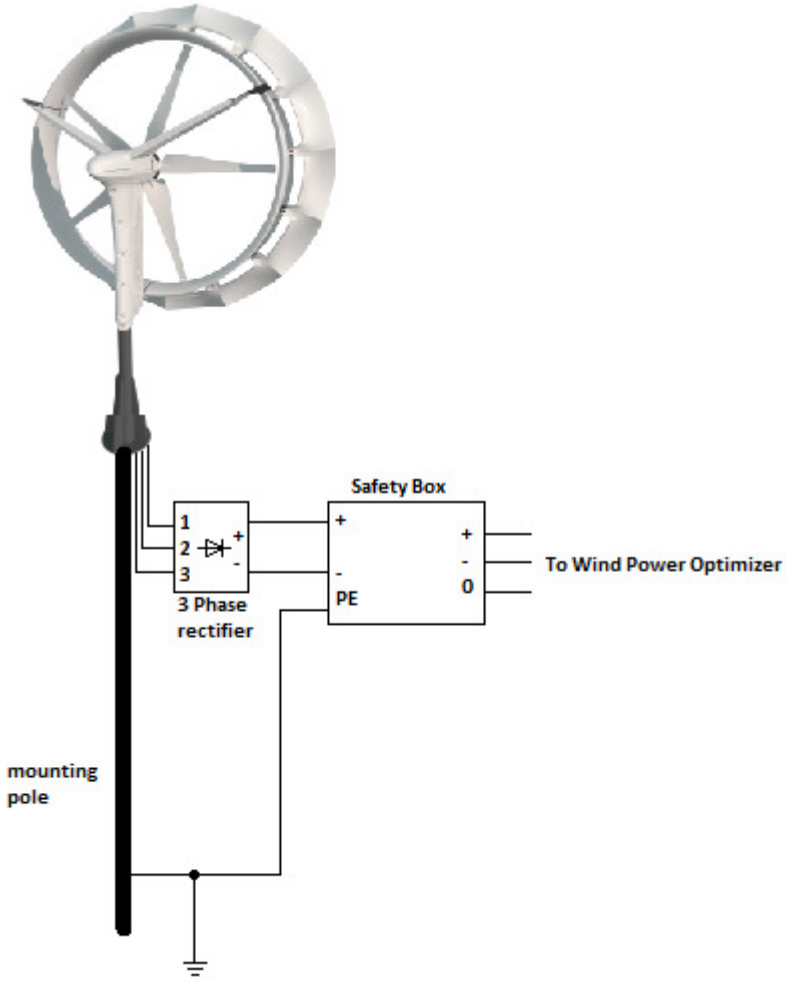
8.2 Connecting the Wind Turbine to the Safety box

The Anakata A018 wind turbine has a 3 phase AC generator. The wires from the 3 phase generator should be connected to a 3 phase rectifier. (Not supplied with the Safety box or the Wind Power Optimizer)

The DC output of the 3 phase rectifier should be connected to the input of the safety box. Use stranded wire conductors with a cross section area of 4 mm^2.

The metal mounting pole of the turbine should be connected to Protective Earth and a suitable conductor should be connected to the Earth connection point on the safety box.



The Femtogrid Safety Box is a Connectbox between the wind turbine and the Wind Power Optimizer. This safety box is delivered separate from the Wind Power Optimizer and the Inverter. The Safety Box must be used for safety reasons, it protects the Turbine by braking it in a controlled sequence during fault conditions.

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The Wind turbine (from the 3 phase rectifier) is connected with 6.3 mm Faston terminals on 3 connection points inside the safety box. Use the right type of Faston terminals for the conductor size used.

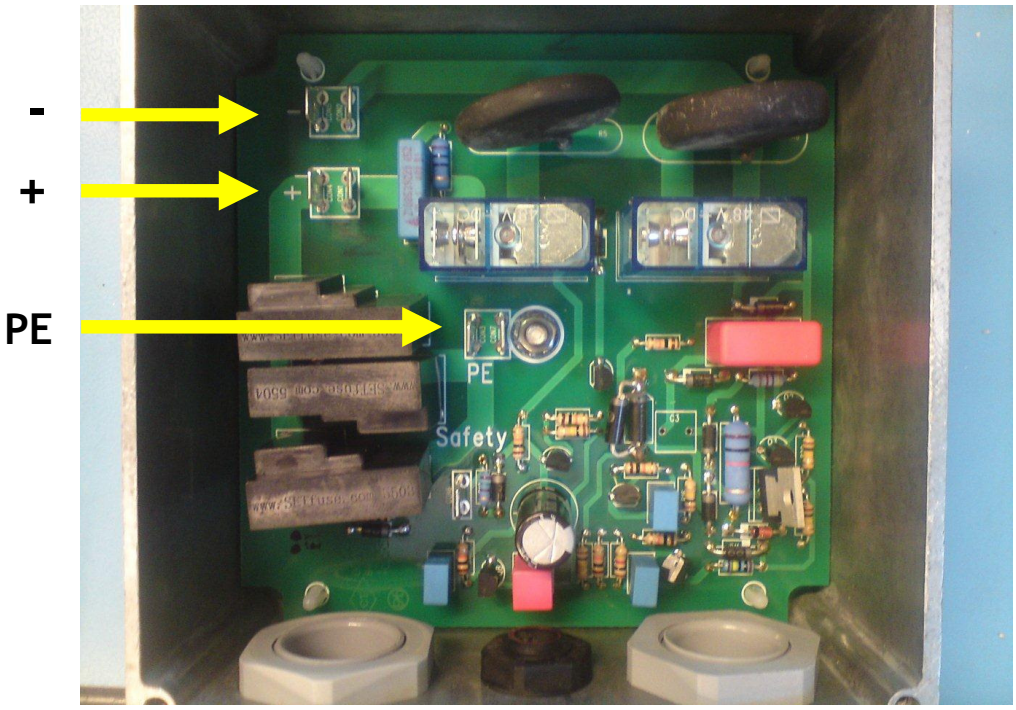
Stranded wire conductors with a cross-section area of 4 mm^2 must be used.

- Connect the positive voltage (‘+’) from the 3 phase rectifier to the ‘+’ terminal in the safetybox.

- Connect the negative voltage (‘-’) from the 3 phase rectifier to the ‘-’ terminal in the safetybox.

- Connect the Earth Connection wire to the ‘PE’ terminal in the safetybox.

These 3 connection points are indicated with arrows in the picture below. The name of the signal is printed on the PCB board near the Faston connection point.



Wind turbine Wind Power Optimizer

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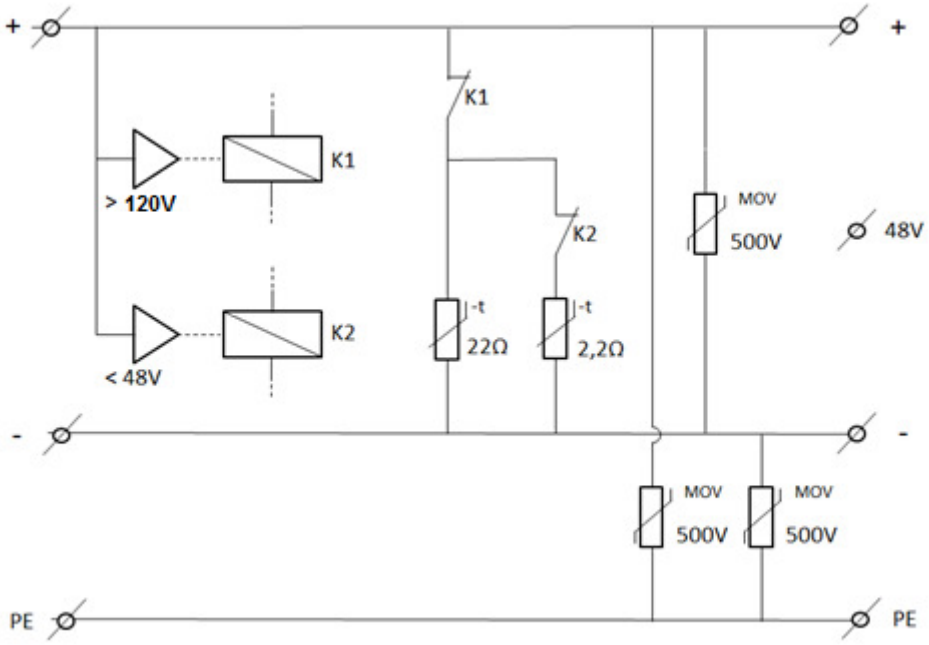
8.3 Functional schematic of Safety Box

Wind Turbine



Power Optimizer

8.4 Connection from the Safety box to the Wind Power Optimizer

The connection between the safety box and the Wind Power Optimizer is made with a 3 wire cable. The cable must have stranded wire conductors with a cross-section area of 4 mm^2. (We recommend the use of the 4 mm^2 Femtogrid DC cable with Red, Blue and Black wires)

The outer insulation on both ends of the cable should be removed over a sufficient length so the individual wires can be connected inside the Safety box and the Wind Power Optimizer as shown below. (However: try to keep the internal wires as short as possible)

Insert the cable through the Cable gland and fasten the strain-relieve-nut.

Strip the 3 wire ends and crimp a 6.3 mm Faston terminal on the wires. Make sure to use the right type of Faston terminals for the 4mm^2 wires.

When the 4 mm^2 Femtogrid DC cable is used, the following color coding scheme is to be used:

Red = + (POS)
Blue = - (NEG)
Black = safety (‘0’)

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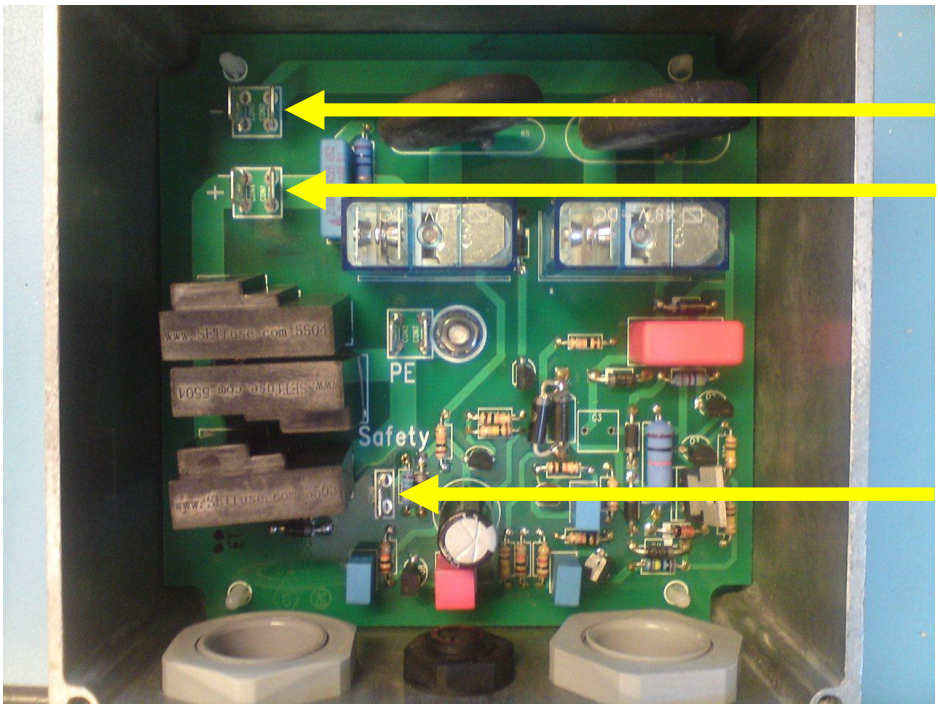
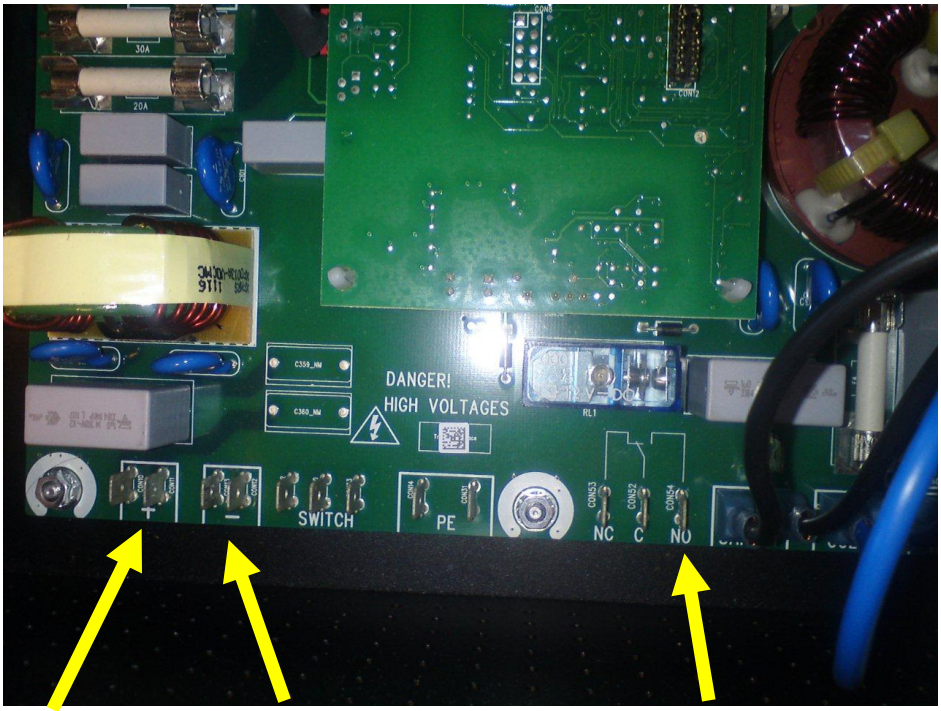
Connections in the Safety Box



Wind turbine Wind Power Optimizer

Connections in the Wind Power Optimizer



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8.5 Connecting the Wind Power Optimizer to the Inverter

Use the 2 meter Female-Female Femtogrid cable (or the custom length cable) made according the instructions in chapter 8.1 to connect the Femtogrid DC output (the connector at the right bottom side) on the Wind Power Optimizer to the Femtogrid DC input connector (connector at the left bottom side) on the Inverter.

9 Commissioning

9.1 Start up

Install, start up and commission the Inverter 2400 first according to the installation instruction provided with the inverter 2400.

The Wind Power Optimizer is automatically powered up together with the power up of the Inverter when the Female –Female Femtogrid cable between the Inverter 2400 and the Wind Power Optimizer is connected correctly.

NOTE: The Safety brake in the Safety Box will not be released immediately. The Wind Power Optimizer will release the Brake function after 3 minutes to allow the Inverter to connect to the Mains grid first. This means that the turbine will only start rotating after 3 minutes.

The user will follow the next steps after starting up the Wind Power Optimizer the first time.

- Adjust / select the language.
- Adjust / set the date and time.

9.2 Monitoring

When a monitoring box is installed you can join the Wind Power Optimizer to the wireless network by pressing the button shortly on the monitoring box with a pointy object like a tooth pick. You have two minutes to navigate on the Wind Power Optimizer user interface to the

Settings menu -> Zigbee network -> search network

And press enter.

After entering this menu item the Wind Power Optimizer will join the wireless network and when it has done so it will show on the display “Joined Network”

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10 User Menu

10.1 Menu map

Main menu

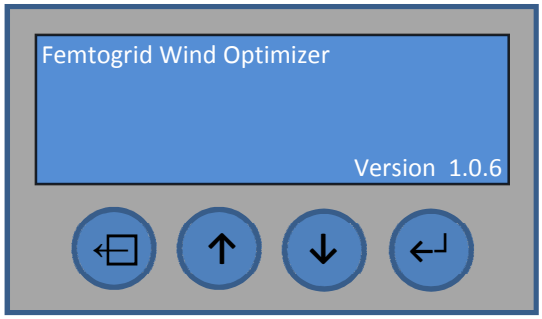
- 24h Energy Graph
- Settings
  - Time / Date
  - ZigBee Network
    - Network state
    - Nodelist
    - Search network
    - Leave network
  - Language
    - English
    - Nederlands
    - Deutsch
    - Espagnol
    - Italiano
    - Francais
  - Edit PIN (1)
  - Service (1)
    - Power gain
    - Gust factor
    - Monitoring
- Software versions

(1) Requires installer PIN code (editable by installer)

10.2 Menu manual

Boot screen

The boot screen is displayed during the startup sequence of the Wind Power Optimizer. When the Wind Power Optimizer finished its startup sequence the display will show the home screen.



Button function	
Back	None
Up	Display previous value
Down	Display next value
Enter	Open menu

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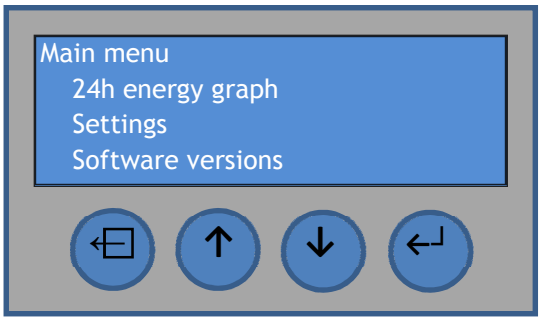
Homescreen

The home screen is the default screen the inverter will always return to.

The home screen can display several values such as: status of the inverter, total energy generated, energy generated today and current power.

To switch between values use the up/down buttons. To enter the menu of the Wind Power Optimizer press the Enter button in the home screen.



Button function

Back None

Up Display previous value

Down Display next value

Enter Open menu

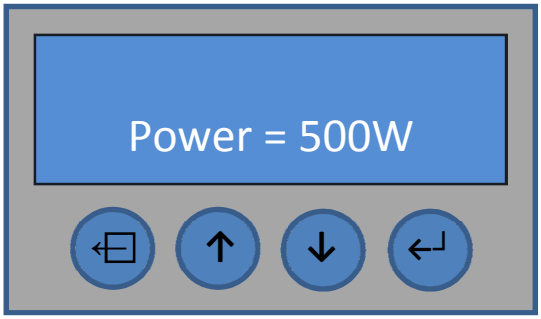
Menu screen

The inverter screen is equipped with a graphical menu interface in which various settings and functions can be accessed.

At the top of the screen the title of the menu is displayed regardless of the scroll position in the menu.

Below the menu title the menu items are displayed. The selected menu item is displayed with an inverted background color.

At the right of the screen the scrollbar indicates the position of the selected menu item in regard to all the items in the current menu.



Button function

Back Go to previous menu/home screen

Up Select the menu item above

Down Select the menu item below

Enter Select menu item

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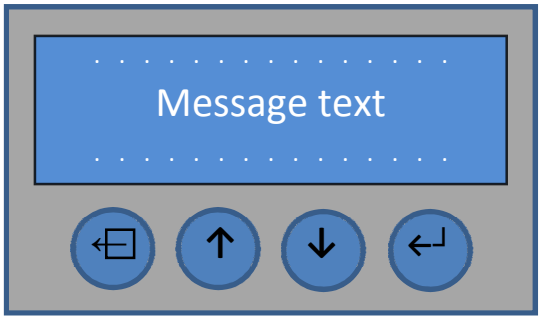
Push message

When the inverter has an important message to show to the user, it will use a push message.

In this screen the user is alerted of current events.

To exit the push message press the Enter or back button.

In case of an ongoing blocking event the user will not be able to exit the push message.



Button function

Back Exit push message

Up None

Down None

Enter Exit push message

Value edit screen

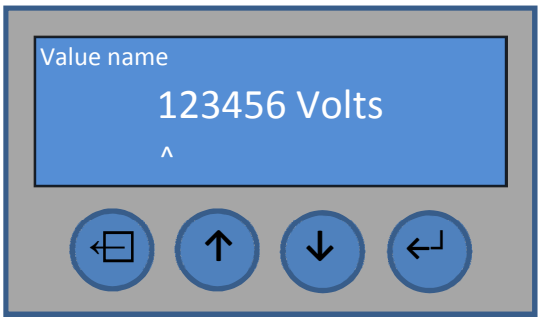
To enter or modify a value on the display screen the user is presented with an value edit interface.

In this screen the title of the value is displayed in the upper left corner of the screen. The actual value is displayed in the centre of the screen optionally with its unit.

Below the value an indicator arrow is displayed the indicator arrow points to the current editable digit. To change the digit's value use the up/down keys.

To select the next digit press the enter button. When the last digit is already selected and the enter button is pressed the interface will save the value and exit.

To select the previous digit press the back button. When the first digit is already selected the interface will return.



Button function

Back Select previous digit/exit screen

Up Raise value

Down Lower value

Enter Select next digit/save value and exit

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Error codes and warning messages
When the display presents an error code or warning message, please check the website www.femtogrid.com for references.

24h energy graph
The Wind Power Optimizer shows a graphical presentation of the energy that is generated in the last 24 hours. This is only possible if the Wind Power Optimizer is active for more than 24 hours.

Software versions
This menu item shows the software version of the Wind Power Optimizer. Our customer service can ask for this version number during a service call.

Settings
In this menu item several settings can be changed. This includes time and date, Zigbee network, language and device settings and information.
Some setting can only be changed after entering a PIN code.

Zigbee Network
In this menu information and commands for the zigbee network can be given.

Edit installer PIN
If you have the installer PIN code you can change it here to avoid unauthorized access to the settings.

Service
With the installer PIN code it is possible to view details and change settings.

In normal use, it is not necessary to enter this menu and is mainly used for trouble shooting.

Gust Control:
One of the settings that can be changed is the Gust factor. This adjustable factor is set by the factory to the proper value for the specific turbine.
This factor changes the response to falling winds (0- means rising and falling response are the same)

It depends on the type of turbine, mass, blades, type of wind , ratio gust-constant flow and so on.

Special setting: " 10 "
!!!!! This setting can be used for wind tunnel testing only !!!!!! Set back to " 0" after the test.

In this mode the Wind Power Optimizer reacts like a "normal" curve follower. At each voltage a load is presented at the input and it continues doing this until the max load is presented. It brakes at overload. Rising and falling winds follow the same curve.
All other functions are disabled.

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In this mode it is not possible to use the processing power of the optimizer. It responses more or less the same as “reprogrammed Solar inverter” so don’t use this mode in the field. It will often stop/overshoot/restart/try to grid connect and leave again. This is unwanted behavior of a controller.

10.3 Forced start/stop function

For maintenance purpose a hidden feature is available. By holding the back button for 5 seconds the turbine can be switched on and off.

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11 Specifications

Type	FG-PO2500-UW001

Wind Input (DC from wind turbine)		
Pmax constant	2500	W
Nominal DC power	2400	W
Voltage range	0/250	Vdc
Brake / safety voltage	120	Vdc
Maximum DC current	25	A
Dumpload	Built in, dynamic	
Power Optimizer Output		
Maximal DC power	250	W
Nominal output voltage (Femtogrid voltage)	380	Vdc
Maximum output current	7	A
Cut in power (sustainable)	5	W
Standard Compliance		
EMC: Immunity	EN61000-4-2/3/4/5/6/11	
EMC: Emission	EN55022/EN60601-1-2/EN61000-3-3	
Safety	EN60950	
CE	yes	
RoHS/WEEE/REACH	yes	
Safety class	Class I	
Protection rating	IP31	
General		
Parallel / Scalable	Yes, to a maximum of 7.5kW with 4 mm^2 cable	
Housing	Indoor	
Dimensions (WxHxD)	325x447x197	mm
Ambient temperature	-10/+65	°C
Weight	±15	kg
DC turbine connections	Internal Fixed with 6.3mm Faston	Type
Output connections	Femtogrid/ Wieland	Type
Safetyline voltage ('neutral')	48	V
Femtogrid feed through current in-out	20	A

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12 Load and Control Graph

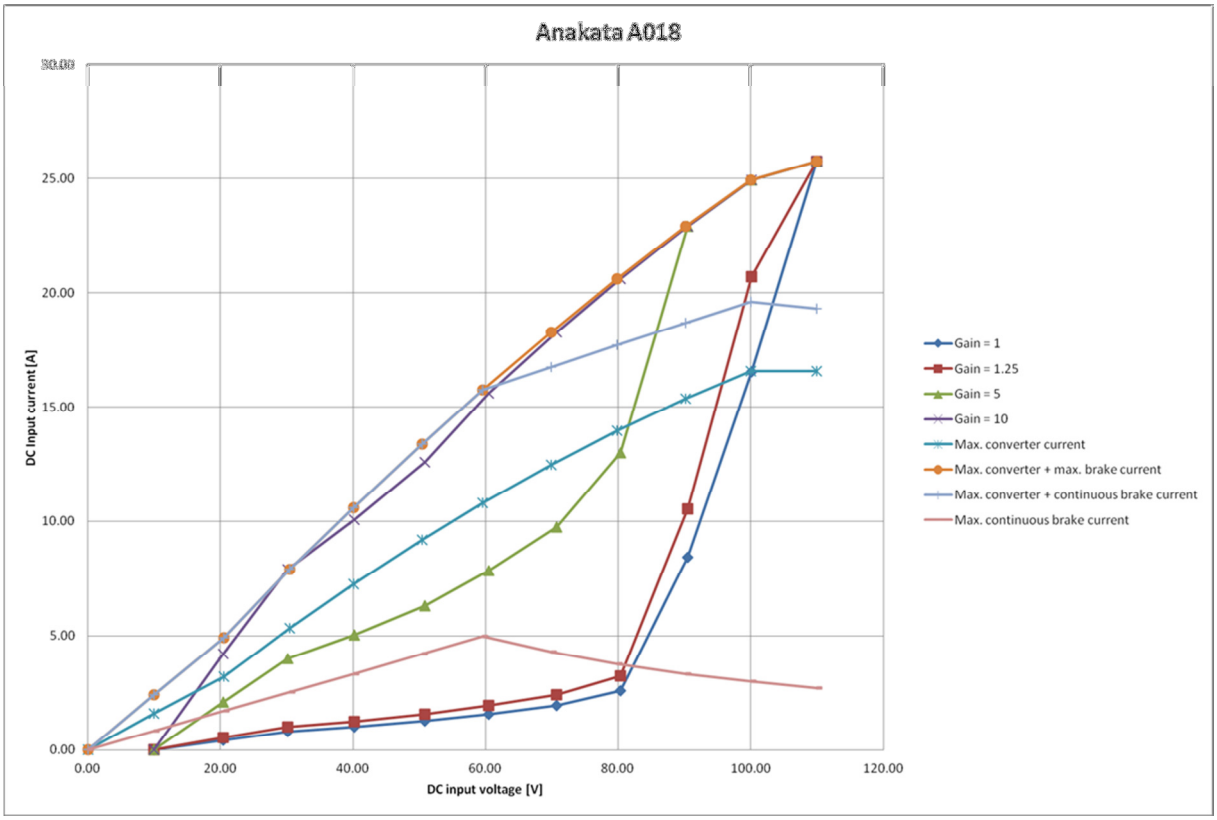
The diagrams below show the load and control graph of the Wind Power Optimizer and inverter for the Anakata A018 turbine.
It gives an indication how much this set can absorb/convert and under what conditions.
Timing variables are not included in this graph (speed responds on gusts, max overshoot time, G(ain) step timing up and down, etc.).

The turbine is electronically kept “close to the edge” of escaping (Pwind > Pmax generator) to get/keep it at maximum efficiency at > 8-10 m/sec. (Betz).

Blue is the normal load line.
Red is the load line if it passes 90 vdc for x second
Green is the load line if it passes 90 vdc for x+x seconds.
Purple is the load line if it passes 90 vdc for x+x+x seconds

Light purple is the maximum diversions load (continuous)
The (*) blue line is the conversion capacity power.
The orange is the max load line the converter and diversion load can generate.

DC input Current vs. DC input Voltage



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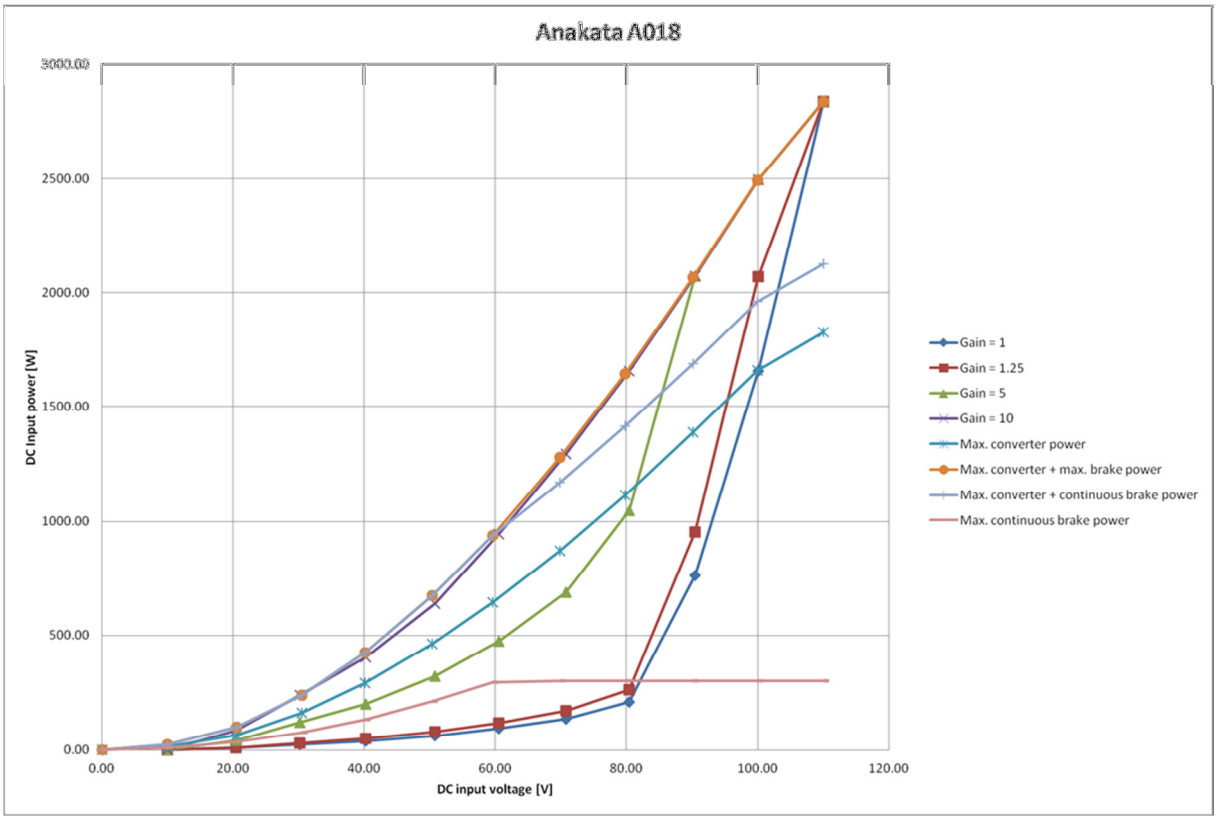
DC input Power vs. DC input Voltage



13 Company information

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